

component of a BIOPAC or National Instruments data acquisition system. In other implementations, the ADC 216 records and saves the sensor data from the sensors 110. The data is later provided to the diagnostic system 104 for “off-line” analysis at a time after the recording of the data. In some implementations, the ADC 216 may sample the data at about 128 Hz, at about 256 Hz, at about 512 Hz, at about 1024 Hz, at about 2024 Hz, or a higher sampling rate (for example at about the Nyquist rate of the signal being digitized). In some implementations, the ADC 216 is configured to digitize the signals received at each of its ports at different sampling rates responsive to the Nyquist rate of each of the signals. For example, respiration rate (with a relatively low Nyquist rate) may be recorded at a lower frequency than heart rate (with a relatively higher Nyquist rate). In some implementations, the ADC 216 filters the data (e.g., with a low pass or notch filter) to remove noise (or other artifacts) from the signals coming from the sensors 110.

FIG. 3 illustrates a flow chart of an example method 300 for diagnosing psychological trauma in a subject. The method 300 includes exposing the subject to stimuli (step 302). Physiological signals are collected from the subject with a plurality of sensors (step 304). Features are then extracted from the physiological signals (step 306). The subject is then classified responsive to the extracted features (step 308).

As set forth above, and referring to FIGS. 1 and 2, the method 300 includes exposing the subject to stimuli (step 302). Prior to exposing the subject to the stimuli, a plurality of sensors is coupled to the subject to collect physiological signals. After coupling the monitoring equipment (e.g., sensors) to the subject, the subject is exposed to the stimuli. In some implementations, the stimuli begin with a baseline, non-traumatic stimuli. After the baseline period, the diagnostic system 104 presents traumatic stimuli to the subject 103. For example, a video may include a Humvee driving scene. The scene begins and continues in a peaceful manner for approximately 30, 75, 120, 165, and 210 seconds to establish a baseline recording. Then different stimuli are presented to the subject 103 at different intervals. For example, the stimuli may include an aircraft flying overhead, a mortar explosion, an improvised explosive device (IED), an attack resulting in an explosion, and an attack by an insurgent.

As the subject 103 is exposed to the stimuli, one or more physiological signals are collected from the subject 103 with one or more sensors (step 304). As described above, the sensors collect, among others data types, respiration data, electrocardiogram data, electroencephalography data, pulse oximetry (including finger pulse amplitude) data, and electrodermal (e.g., skin conductance) data. The sensors are used as inputs to the ADC 216 of the diagnostic system 104. The ADC 216 conditions the collected signals for analysis and classification by the diagnostic module 106. For example, conditioning the signal can include filtering the signal to remove noise or amplifying the signal. In some implementations, the signals are collected and passed directly to the diagnostic module 106 for classification. In other implementations, the signals are stored in the memory 210 of the diagnostic system 104 for later analysis.

Features are then extracted from the collected signals (step 306). Examples of suitable features, include, without limitation, an area to full recovery, an area to half recovery feature, a peak amplitude, a standard deviation, a rise time from a first low point, a rise time from a response onset, a rise rate from a first low point, a time to full recovery of the signal (e.g., time to return to baseline), a latency time (e.g., the time between the presentation of the stimulus and the beginning of a change in the signal), and an average value. The features can be

extracted for each physiological characteristic monitored by the sensors 110. For example, the feature extraction module 208 may extract an area to full recovery and peak amplitude from the skin conductance signal, an area to half recovery from the inter-heartbeat interval, a peak amplitude of the skin conductance, an average value of the skin conductance, the amplitude of the inter-beat interval signal.

The extracted features from the signal are then used to classify and diagnose the subject (step 308). In some implementations, two or more of the extracted features are processed by classification module 206 to determine if the subject 103 suffers from PTSD or another type of disorder. In some implementations, the method 300 also includes determining a threshold responsive to at least one of an age of the subject, an ethnic background of the subject, a sex of the subject, and a baseline response of the subject. In these implementations, the classification module 206 combines and applies weights to the processed extracted features and compares the combined value to the threshold. The weighted features can be combined simply by adding them together, multiplying them together, combining them according to a polynomial expression, or any other arithmetic process. In such implementations, the classifier identifies a subject 103 as having PTSD if the combined value exceeds the threshold, and not having PTSD if the combined value falls below the threshold. In other implementations, the diagnostic module 106 returns a likelihood value corresponding to a determined likelihood that the subject has PTSD. In some implementations, the method also includes displaying the results of the classification to a clinician, care provider, and/or to the subject by outputting the results via a display device coupled to the display driver.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The forgoing implementations are therefore to be considered in all respects illustrative, rather than limiting of the invention.

What is claimed is:

1. A method for detecting a stress disorder:

exposing a subject to a stimulus;

collecting, with a plurality of sensors, a plurality of physiological signals during the subject’s exposure to the stimuli, the plurality of physiological signals comprising at least an interbeat interval signal and a skin conductance signal;

extracting a feature from each of the plurality of physiological signals; and

classifying the subject into one of a first category indicating the subject is suffering from post-traumatic stress disorder, a second category indicating the subject is not suffering from post-traumatic stress disorder, or a third category indicating the subject was exposed to a traumatic event but does not suffer from post-traumatic stress disorder based on a function of the extracted features.

2. The method of claim 1, wherein the extracted features includes at least one of an area under one of the plurality of physiological signals from exposure to the stimuli to full recovery feature, an area under one of the plurality of physiological signals from exposure to the stimuli to half recovery feature, a peak amplitude feature, a standard deviation feature, a rise time from a first low point feature, a rise time from a response onset feature, a rise rate from a first low point feature, a time to full recovery from exposure to the stimuli, a latency time, and an average value feature.

3. The method of claim 1, wherein the stimuli comprise at least one of audio stimuli and visual stimuli.